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(71) Applicant and

(72) Inventor: RINTA-JOUPPI, Yrjö [FI/FI]; Kiviveistämön-
tie 49, FIN-28760 Pori (FI).

(72) Inventor: FAGERSTRÖM, Asko; Souramontie 12, FIN-
28660 Pori (FI).

(74) Agent: PAPULA OY; P.O. Box 981, FIN-00101 Helsinki
(FI).

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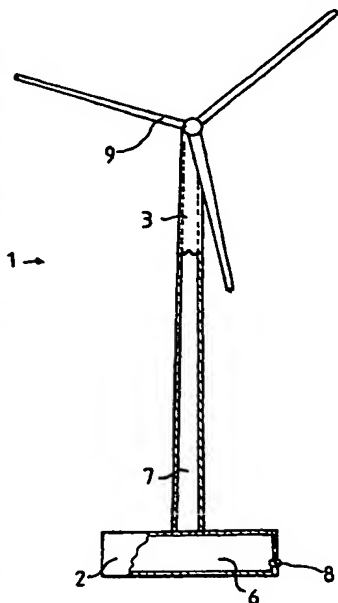
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ance Notes on Codes and Abbreviations" appearing at the begin-
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(54) Title: METHOD AND SYSTEM FOR INSTALLING AND TRANSPORTING AN OFFSHORE WIND POWER STATION
AT SEA



(57) Abstract: A method and a system for installing an offshore wind power station (1) at sea and/or transporting one from sea e.g. for maintenance, said wind power station comprising a base (2) to be set on the sea bottom, and a tower (3) attached to the base, which wind power station is transported to a place of installation at sea by means of a transport vessel (4) and lowered to the sea bottom and/or lifted off the sea bottom and transported to land/ashore by means of a transport vessel. The wind power station is lowered by adding ballast water into a ballast water tank (6, 7) provided in the wind power station, and raised by reducing the amount of ballast water in the ballast water tank. The wind power station comprises a ballast water tank (6, 7).

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METHOD AND SYSTEM FOR INSTALLING AND TRANSPORTING AN OFFSHORE WIND POWER STATION AT SEA

5 The present invention relates to a method as defined in the preamble of claim 1. Moreover, the invention relates to a system as defined in the preamble of claim 7. In addition, the invention relates to an offshore wind power station as defined in the preamble of claim 11.

10 In prior art, a method for installing an offshore wind power station at sea is known from specification GB 2327440. The wind power station comprises a wide base and a tower extending vertically from the base and carrying a wind rotor mounted on its top. In
15 the installation method presented in the above-mentioned specification, the tower and the base of the wind power station are transported as a single assembly by using a floating frame, e.g. barges, fastening the base to the bottom surface of the barge, trans-
20 porting it to the place of installation and then lowering it to the sea bottom using means provided on the floating frame, such as chains, wire cables, a lever jack or the like. The floating frame can then be used for the installation of other corresponding base-tower
25 combinations.

 A problem with this prior-art method is that the load capacity of the floating frame used for installation has to be so designed that it will bear the weight of the base and tower in addition to its own
30 weight. The resulting floating frame is very bulky and expensive. Besides, this specification completely neglects the occasional need to raise the wind power station from the sea bottom and transport it to land/ashore for servicing. With equipment built ac-
35 cording to the specification, this would be difficult if not impossible because the base, which may be made of concrete or steel, must be very heavy to resist the

stress exerted on the wind power station by the wind, sea currents, waves and ice. Therefore, the base is provided with ballast material of sand, stones or iron ore. Lifting such a load from the bottom requires a
5 very high external hoisting capacity. Therefore, a special open sea crane ship would be needed for the hoisting operation.

The object of the invention is to eliminate the above-mentioned drawbacks.

10 A specific object of the invention is to disclose a method and system for the transportation of an offshore wind power station that will allow transportation without the transport vessel having to carry the weight of the wind power station at all.

15 A further object of the invention is to disclose a wind power station which can be easily transported back and forth between a place of installation and a place of maintenance and which can be raised and lowered independently in water without using any special hoisting equipment.
20

The features characteristic of the method, system and wind power station of the invention are presented in the claims below.

In the method of the invention, the wind
25 power station is transported to a place of installation at sea by using a transport vessel and lowered to the sea bottom and/or raised from the sea bottom and transported to land/ashore by means of a transport vessel. According to the invention, the wind power
30 station is lowered by adding ballast water into a ballast water tank provided in the wind power station, and the wind power station is raised by reducing the amount of ballast water in the ballast water tank.

In the system of the invention, the wind
35 power station comprises a base to be mounted on the sea bottom, a tower attached to the base, and a transport vessel provided with a gripping device for grip-

ping the wind power station and transporting the wind power station to a place of installation at sea and/or transporting it to land/ashore from the sea. According to the invention, the system comprises a ballast water
5 tank disposed in the wind power station.

The offshore wind power station of the invention comprises a base to be mounted on the sea bottom, and a tower attached to the base. According to the invention, the wind power station comprises a ballast
10 water tank.

Other preferred features and embodiments of the invention are presented in the subclaims below.

In the following, the invention will be described in detail by the aid of a few examples of its
15 embodiments with reference to the attached drawing, wherein

Fig. 1 presents an embodiment of the wind power station of the invention in a diagrammatic side view and partly sectioned,

20 Fig. 2 - 7 present two different embodiments of the system of the invention and different stages in the procedure of the invention.

Fig. 1 presents a wind power station 1 according to the invention. It comprises a wide base 2
25 of e.g. a round slab-like shape, which can be set on the sea bottom. Further, the wind power station comprises a tower 3 attached to the base and extending vertically from it. Mounted on the upper end of the tower 3 is a wind rotor 9. The box-like base 2, which
30 may be made of concrete or steel, is of a hollow construction and the space inside it functions as a ballast water tank or container 6. The tower 3 is likewise of a hollow construction and the space inside it serves as a ballast water tank 7. The interior spaces
35 of the ballast water tanks 6, 7 in the base 2 and tower 3 may be separate spaces or they may communicate with each other. Moreover, the wind power station 1

may comprise a pump or pumps 8, by means of which it is possible to pump sea water into and out of the ballast water tanks 6, 7. The pump 8 may also be disposed on a transport or service vessel 4, in which case the
5 wind power station need not necessarily be provided with ballast water pumps.

The buoyancy of the wind power station in water is so designed that the station is able to float and carry its own weight in water when the ballast water tanks 6, 7 are empty. Correspondingly, when the
10 ballast water tanks 6, 7 are partially or completely filled with water, the wind power station will sink to the bottom.

In Fig. 2, the base 2 and the tower 3 are assembled on land or ashore into a unitary whole by using a crane ashore. The base 2 can be floated separately to the place of installation and lowered onto a firm pedestal resting on the bottom by filling the ballast water tank 6 in the base. On the top of the
20 base 2, a tower 3 is built from one or more parts. Water can also be pumped into the ballast water tank 7 in the tower to increase its firmness. Finally, a machine room and a wind rotor 9 are mounted on the end of the tower 3.

When the wind power station is to be transported to its place of installation at sea, as illustrated in Fig. 3 and 4, the amount of ballast water in the ballast water tanks 6 and 7 in the base 2 and in the tower 3 is so adjusted that the base 2 becomes
25 buoyant and is lifted off the bottom. By adjusting the amount of ballast water in the tank 6, 7, the elevation and stability of the base in relation to the transport vessel 4 are adjusted to make them suitable for transportation. The tower 3 is gripped from a lateral direction from opposite sides by the gripping
30 jaws 10 of a gripping device 5 mounted on the transport vessel, as illustrated in Fig. 4. The grip on the

tower is preferably such that it permits movement of the tower in a vertical direction in relation to the transport vessel but not in other directions. The wind power station is then transported to its place of installation at sea.

Fig. 5 and 6 illustrate an alternative solution for implementing the transport vessel in Fig. 3 and 4. In Fig. 5 and 6, the transport vessel 4 used is a barge 4 having a forked frame with a through slot 11 extending from its middle to the edge, allowing the tower 3 to go through the slot. For transportation, the base 2 can be fastened in a substantially fixed manner to the barge 4. The upper surface of the base 2 lies against the bottom of the barge 4 and is fastened to it by suitable fastening elements 12, such as wire cables, chains, threaded bolts or the like.

Fig. 7 presents a phase in the procedure at which the wind power station has been brought to the place of installation and an amount of water sufficient to increase the weight so as to allow the base 2 to sink to the sea bottom has been pumped into the ballast water tank 6 of the base 2 and into the ballast water tank 7 of the tower 3.

Substantially the entire inside space of the tower 3 constituting the ballast water tank 7 can be filled with water. Providing a ballast water tank in the tower 3 in addition to the base 2, together with an appropriate design, enables the weight of the wind power station to be increased so that it can rest very firmly on the bottom and the wind power station is able to receive the loads generated by wind, sea currents, sea roll and ice, which tend to upset or move the wind power station. Furthermore, providing a ballast water tank 7 in the tower 3 makes it possible to use a base 2 of a relatively light and compact construction.

The base 2 can be provided with water jet equipment (not shown in the figures), by means of which the bottom, if it is e.g. of a sandy nature, can be dredged after the base has sunk against the bottom, thus making it possible to adjust the vertical alignment of the wind power station.

When the wind power station is to be brought ashore from the sea for maintenance, the procedure is naturally reverse to that for installation. The amount of water in the ballast water tanks 6, 7 of the wind power station 1 standing on the bottom is reduced until the buoyancy of the base 2 and tower 3 has lifted the station off the bottom and raised it to a level near the surface. Via the ballast water tank 6, 7, the elevation and stability of the wind power station are adjusted to make them suitable in relation to the transport vessel 4 used for transportation. The tower 3 is then gripped from opposite sides by the gripping device 5 of the transport vessel 4 and the wind power station is transported away from the place of installation to a place of maintenance.

The invention is not restricted to the examples of its embodiments described above; instead, many variations are possible within the scope of the inventive idea defined in the claims.

CLAIMS

1. Method for installing an offshore wind power station (1) at sea and/or transporting one from sea e.g. for maintenance, said wind power station comprising a base (2) to be mounted on the sea bottom, and a tower (3) attached to the base, which wind power station is transported to a place of installation at sea by means of a transport vessel (4) and lowered to the sea bottom and/or lifted off the sea bottom and transported to land/ashore by means of a transport vessel, characterized in that the wind power station is lowered by adding ballast water into a ballast water tank (6, 7) provided in the wind power station and that the wind power station is raised by reducing the amount of ballast water in the ballast water tank.

2. Method as defined in claim 1, characterized in that vertical motion of the wind power station (1) in relation to the transport vessel (4) is permitted during the transportation.

3. Method as defined in claim 1 or 2, characterized in that, to install the wind power station at sea, the wind power station is gripped by a gripping device (5) mounted on the transport vessel (4); the elevation and stability of the wind power station are adjusted by the aid of the ballast water tank (6, 7) to make them suitable with respect to the transport vessel; the wind power station is transported to the place of installation at sea; and the wind power station is lowered at the place of installation to the sea bottom by filling the ballast water tank (6, 7).

4. Method as defined in claim 1 or 2, characterized in that, to transport the wind power station from sea, the amount of water in the ballast water tank (6, 7) is reduced until the wind power station has risen off the bottom to a level near

the surface; using the ballast water tank (6, 7), the elevation and stability of the wind power station are adjusted to make them suitable in relation to the transport vessel (4); the wind power station is gripped by the gripping device (5) of the transport vessel (4); the wind power station is transported ashore from the place of installation, e.g. to a place of maintenance; and the wind power station is released from the grip of the transport vessel.

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5. Method as defined in any one of claims 1 - 4, characterized in that a ballast water tank (6) disposed in the base (2) of the wind power station is used, and/or that a ballast water tank (7) disposed in the tower (3) of the wind power station is used.

20
6. Method as defined in any one of claims 1 - 5, characterized in that the tower (3) of the wind power station is gripped by the gripping device (5) of the transport vessel (4) from opposite sides.

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7. System for installing an offshore wind power station (1) at sea and/or transporting one from the sea e.g. for maintenance, said wind power station comprising a base (2) to be set on the sea bottom, and a tower (3) attached to the base, and a transport vessel (4) provided with a gripping device (5) for gripping the wind power station to transport it to a place of installation at sea and/or from the sea to land/ashore, characterized in that the system comprises a ballast water tank (6, 7) disposed in the wind power station.

35
8. System as defined in claim 7, characterized in that the system comprises a pump (8) disposed on the vessel (4) or on the wind power station (1) for pumping ballast water into/out of the ballast water tank (6, 7).

9. System as defined in claim 7 or 8, characterized in that the base (2) is provided with a ballast water tank (6) and/or that the tower (3) is provided with a ballast water tank (7).

5 10. System as defined in any one of claims 7 - 9, characterized in that the gripping device (5) of the transport vessel comprises gripping jaws (8) for gripping the tower (3) from a lateral direction from its opposite sides, said gripping jaws
10 being designed to allow vertical motion of the tower in relation to the transport vessel (4).

 11. Offshore wind power station comprising a base to be set on the sea bottom and a tower (3) attached to the base, characterized in that
15 the wind power station comprises a ballast water tank (6, 7).

 12. Offshore wind power station as defined in claim 11, characterized in that the base (2) is provided with a ballast water tank (6) and/or that
20 the tower (3) is provided with a ballast water tank (7).

 13. Offshore wind power station as defined in claim 11 or 12, characterized in that the wind power station (1) comprises a pump (8) for pump-
25 ing ballast water into/out of the ballast water tank (6, 7).

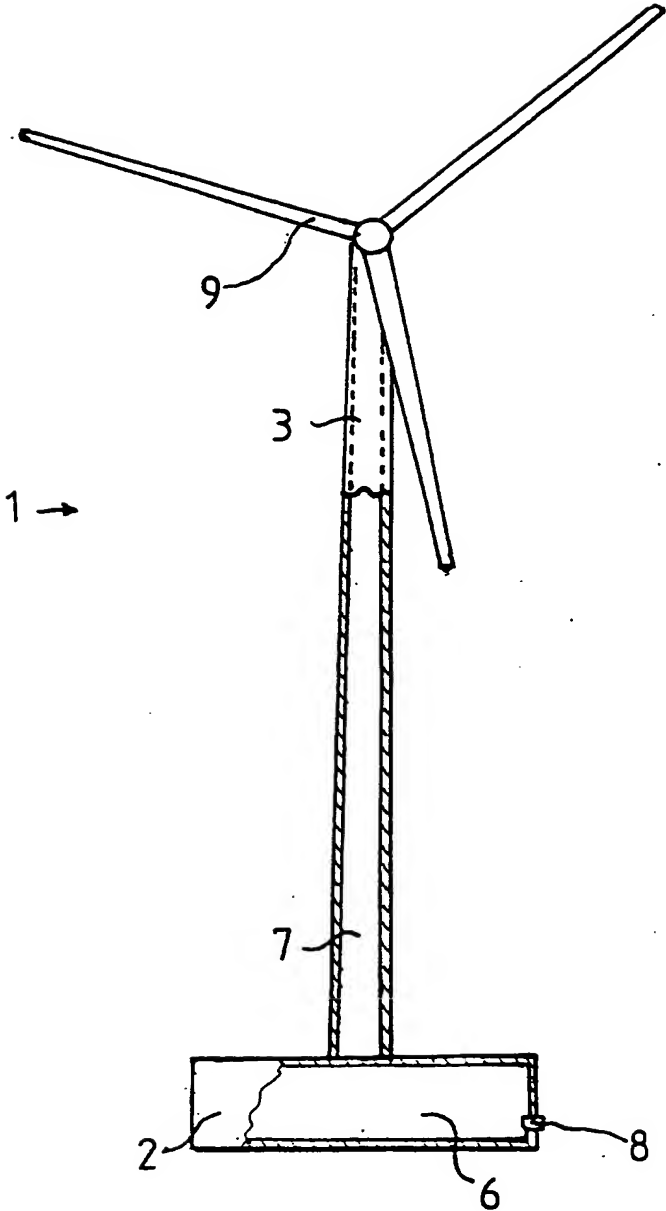


Fig 1

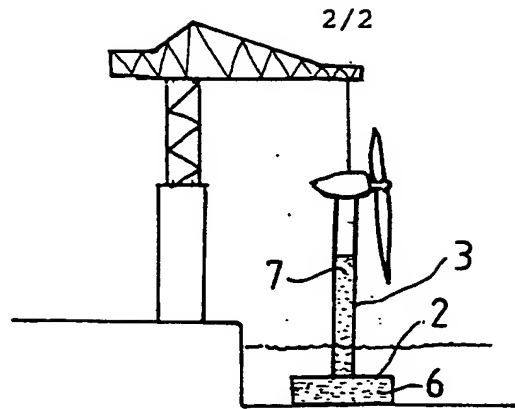


Fig 2

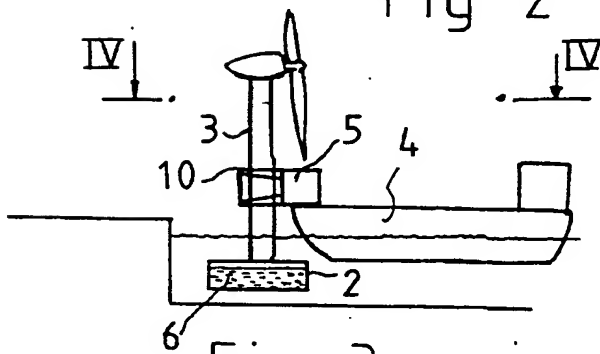


Fig 3

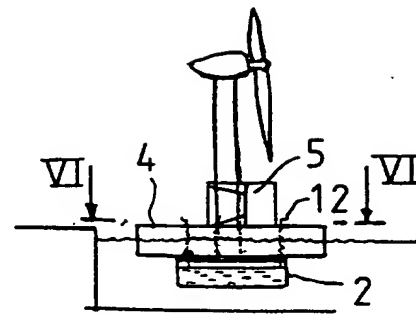


Fig 5

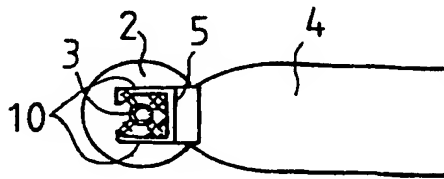


Fig 4

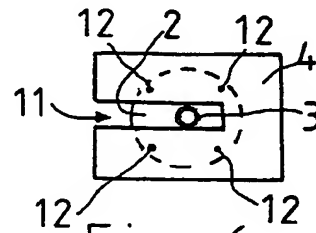


Fig 6

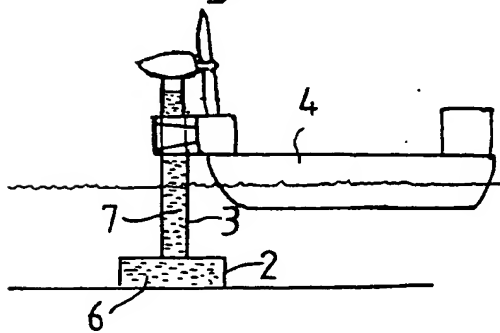


Fig 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00951

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F03D 11/04, E02B 17/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F03D, E02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2225365 A (NORWEGIAN CONTRACTORS A/S), 30 May 1990 (30.05.90), page 3, line 32 - page 4, line 17, figures 1-4 --	1-13
A	GB 2327970 A (KVAERNER OIL & GAS LIMITED), 10 February 1999 (10.02.99), figures 1-5, claim 1, abstract --	1-13
A	GB 2327449 A (KVAERNER OIL & GAS LIMITED), 27 January 1999 (27.01.99), page 4, line 25 - page 6, line 30, figures 7-14 --	1-13

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

Date of mailing of the international search report

2 February 2001

08-02-2001

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Peter Göransson / JA A
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00951

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9943956 A1 (BONUS ENERGY A/S), 2 Sept 1999 (02.09.99), abstract -- -----	1-13

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-5 and 7-9 refer to a method and a system for installing an offshore wind power station at sea.
2. Claims 6 and 10 regard a gripping device.
3. Claims 11-13 refer to an offshore wind power station comprising a ballast water tank.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

27/12/00

International application No.
PCT/FI 00/00951

Patent document cited in search report				Publication date		Patent family member(s)		Publication date	
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				NO	885078 A	16/05/90			
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				GB	9809229 D	00/00/00			
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GB	2327449	A	27/01/99	GB	9706679 D	00/00/00			
				GB	9807135 D	00/00/00			
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				EP	1058787 A	13/12/00			
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